J. Helminthol. Soc. Wash.
60(1), 1993, pp. 62–66

Annotated List of Metazoan Parasites Reported from the Blue Whale, *Balaenoptera musculus*

LENA N. MEASURES
Maurice Lamontagne Institute, Fisheries and Oceans, P.O. Box 1000,
Mont-Joli, Quebec, Canada G5H 3Z4

ABSTRACT: A list of all metazoan parasites reported from blue whales, *Balaenoptera musculus* (L.), indicates that of 18 endohelminth species and 8 ectoparasites or epizoa reported worldwide only 2 (*Tetrabothrius schaeferi* Markowski, 1955 and *Crassicauda tortilis* Skrjabin, 1959) are restricted to blue whales. All other reported parasites have been found in other species of mysticetes, odontocetes, or pinnipeds. The acquisition of parasites by blue whales, which have a moderate diversity of parasites, is probably restricted by their highly specialized euphausid diet. Two parasites of blue whales, *Anisakis simplex* (Rudolphi, 1809) and *Diplogonoporus balaenopterae* (Lonnberg, 1892), are known zoonotic pathogens.

KEY WORDS: parasites, blue whale, *Balaenoptera musculus*, zoonoses, epizootiology.

Whales harbor a variety of parasites, some of which have zoonotic potential. An understanding of the epizootiology and population dynamics of parasites of whales is essential to understand their effects on fish, fisheries, and whale populations themselves. Early parasitological studies of whales, mostly mysticetes taken during commercial whaling, were conducted primarily in Antarctica and the North Pacific Ocean and consisted of descriptions of new species, reports of new host and geographic distributions, and some observations of lesions. The blue whale, *Balaenoptera musculus* (Linnaeus, 1758), was hunted from 1883 to 1966 and is currently officially protected by international agreement (Small, 1971).

With increasing interest in marine mammals by scientists and environmental groups it was considered worthwhile to assemble the literature on parasites of blue whales. Parasite–host lists for marine mammals have been published by Margolis (1954), Delyamure (1955), Margolis and Dailey (1972), Dailey and Brownell (1972), and Arvy (1982). In the present paper reports of parasites of blue whales were obtained from the primary literature where possible. Localities given are as precise as possible; however, most early whalers and some biologists did not specify exact locations of their catches.

An examination of reported metazoan parasites of blue whales reveals that they harbor members of most major parasitic phyla (Table 1). All epizoa have been reported from other whales with none being unique to blue whales (Arvy, 1977). Epizoa such as *Odontobius ceti* and *Balaenophilus unisetus* are commensals on the baleen, while *Conchoderma virgatum* has only been found attached to *Pennella balaenopterae*. *Pennella balaenopterae* attaches to the skin and blubber of blue whales. The lamprey, *Entosphenus tridentatus*, and remora are predatory vertebrates that do not remain permanently attached to whales. The epizoa of cetaceans have been reviewed by Arvy (1982).

Most endoparasites reported from blue whales are also found in pinnipeds or other whales (mysticetes and odontocetes). Except for *Tetrabothrius schaeferi* and *Crassicauda tortilis*, blue whales do not possess any unique helminths. The taxonomy of *Crassicauda* with many species described only from cephalic and posterior extremities is still problematic (see Lambertsen, 1985; Raga and Balbuena, 1990).

Blue whales are euphausid or "krill" specialists (Nemoto, 1959). The few reports of fish in the stomach of blue whales (Klumov, 1963; Lockyer 1981; Yochem and Leatherwood, 1985) have been considered as accidental ingestions with negligible epizootiological significance for blue whales.

The life cycle of most endoparasites of marine mammals is poorly known. Gastric nematodes such as *Anisakis simplex* are believed to use euphausids as intermediate or paratenic hosts (Smith, 1983), and this is the likely source of infection for blue whales. However, it has not been established whether fish are obligate second intermediate hosts for *A. simplex*. *Pseudoterranova decipiens* is a gastric parasite of seals, and blue whales may acquire larvae from infected pelagic crustaceans. Evidence, however, suggests transmission of *P. decipiens* involves benthic in-

Copyright © 2011, The Helminthological Society of Washington

Table 1. Reported metazoan parasites of blue whales (*Balaenoptera musculus*).

Ectoparasites/epizoa	Locality*	Reference†
Copepoda		
Balaneophilus unisetus Aurivillius, 1879	H	20, 21
Pennella balaenopterae Koren and Danielssen, 1877	HID	21, 28, 33, 37
Cirripedia		
Xenobalanus globicipitis Steenstrup, 1851	HD	20, 21, 37
Coronula reginae Darwin, 1854	D	5, 31, 37
Conchoderma auritum (Linnaeus, 1767)	ABD	9, 14–18, 25, 37
C. virgatum (Spengler)	AD	14, 37
Nematoda		
Odontobius ceti Roussel de Vauzème, 1834	DEGH	4, 10, 21, 23
Amphipoda		
Cyamus balaenopterae Barnard, 1931	AH	1, 2, 12
C. bahamondei Buzeta, 1963	H	30
Cyamus sp.	D	9, 18, 37
Pisces		
Entosphenus tridentatus (Richardson, 1836)	H	20, 21
Remora australis (Bennett, 1840)	H	20, 21,29, 35
Remora sp.	HL	11, 22
Cestoda		
Diplogonoporus balaenopterae (Lonnberg, 1892)	BEF	8, 10, 13
Priapocephalus grandis (Nybelin, 1922)	ABDEFKM	4, 6, 8, 10, 13
Tetrabothrius affinis (Lonnberg, 1891)	ABDEFM	4, 6, 8, 10, 13, 31
T. wilsoni (Leiper and Atkinson, 1914)	ABE	8, 10, 13
T. schaeferi Markowski, 1955	BEF	8, 10, 13
Tetrabothrius sp.	D	5, 8, 31
Digenea		
Ogmogaster antarcticus (Johnston, 1931)	E	6, 10
O. plicatus (Creplin, 1839)	DK	4, 6, 10, 32, 34
Nematoda		
Anisakis simplex (Rudolphi, 1809)	DEKN	4, 6, 8, 10
Anisakis sp.	G	23
Crassicauda crassicauda (Creplin, 1829)	BDEHK	4, 6, 7, 8, 10, 21, 36
C. tortilis Skrjabin, 1959	G	23
C. boopis (Baylis, 1920)	B	7, 8
Pseudoterranova decipiens (Krabbe, 1878)	E	6, 10
Acanthocephala		
Bolbosoma turbinella (Diesing, 1851)	DEGJK	4, 6, 10, 19, 26, 27
B. balaenae (Gmelin, 1790)	DEKO	4, 6, 10, 26
B. brevicolle (Malm, 1867)	ABCDEK	3, 4, 6, 8, 10
B. hamiltoni (Baylis, 1929)	BE	3, 4, 6, 8, 10
B. nipponicum Yamaguti, 1939	GH	21, 23
B. paramuschiri Skrjabin, 1959	G	23
Bolbosoma sp.	H	20

* A, Southeast Atlantic Ocean; B, South Atlantic Ocean; C, Southwest Atlantic Ocean; D, Antarctic waters; E, Arctic waters; F, Southern Ocean; G, Northwest Pacific Ocean; H, Northeast Pacific Ocean; I, Northeast Atlantic Ocean; J, Northwest Atlantic Ocean; K, North Atlantic Ocean; L, North Indian Ocean; M, North Pacific Ocean; N, Southeast Pacific Ocean; O, Tasman Sea.

† 1, Barnard (1931); 2, Barnard (1932); 3, Baylis (1929); 4, Baylis (1932); 5, Cockrill (1960); 6, Delyamure (1955); 7, Gibson (1973); 8, Gibson and Harris (1979); 9, Kakuwa et al. (1953); 10, Klumov (1963); 11, Leatherwood et al. (1984); 12, Margolis and Dailey (1972); 13, Markowski (1955); 14, Nilsson-Cantell (1930); 15, Nilsson-Cantell (1939); 16, Nishiwaki and Hayashi (1950); 17, Nishiwaki and Oye (1951); 18, Ohno and Fujino (1952); 19, Porta (1908); 20, Rice (1963); 21, Rice (1978); 22, Rice and Caldwell (1961); 23, Skrjabin (1959); 24, Yochem and Leatherwood (1985); 25, Clarke (1966); 26, Petrochenko (1958); 27, Measures (1992); 28, Turner (1905); 29, Follett and Dempster (1960); 30, Berzin and Vlasova (1982); 31, Rees (1953); 32, Skrjabin (1969); 33, Quidor (1910); 34, Jagerskiold (1891); 35, Carl and Wilby (1945); 36, Baylis (1920); 37, Mackintosh and Wheeler (1929).

Copyright © 2011, The Helminthological Society of Washington

vertebrates and fish (McClelland, 1990). Both of these species can infect humans (Jackson, 1975; Margolis, 1977). The life cycles of *Crassicauda* spp. that inhabit the fascia, cranial sinuses, mammary glands, and urogenital system in whales are unknown. Life cycles are probably heteroxenous, involving an arthropod, such as a crustacean, intermediate host as do most spirurids. Lambertsen (1986), however, suggested that a direct life cycle may be involved.

Acanthocephalans in the intestines of whales are not particularly host specific. A number of species of acanthocephalans have been reported in the same species of whale, but an individual whale host usually has only one species of acanthocephalan in its intestine (Petrochenko, 1956). Acanthocephalans with aquatic life cycles use arthropod intermediate hosts such as amphipods, ostracods, or other crustaceans. Shimazu (1975) reported juvenile *Bolbosoma caenoforme* in 2 species of euphausids collected in the North Pacific Ocean. *Bolbosoma* sp. can infect humans but this is considered rare (Beaver et al., 1983; Tada et al., 1983).

The life cycles of the intestinal notocotylids *Ogmogaster plicatus* and *O. antarcticus* are unknown and the latter has also been reported in pinnipeds. *Diplogonoporus balaenopterae* found in the intestines of whales presumably has a typical pseudophyllidean life cycle (crustacean first intermediate host, fish second intermediate host). *Diplogonoporus balaenopterae* has been involved in almost 100 human cases of infection in Japan. It is likely acquired by eating raw fish or squid, but plerocercoids of *D. balaenopterae* in fish or squid have not been reported (Oshima and Kliks, 1986). Copepods were shown to be first intermediate hosts (Kamo et al., 1973). The biology of the intestinal tetrabothriids *Priapocephalus grandis* and *Tetrabothrius* spp. is unknown. Crustaceans, cephalopods, and/or teleosts are suggested as intermediate and/or paratenic hosts of tetrabothriids. However, two-host cycles (blue whales acquiring larval cestodes from their crustacean prey) may occur (see Hoberg, 1987).

Blue whales are migratory and this vagility could contribute to the acquisition of a great diversity of parasites. As shown here blue whales have a moderate diversity of parasites. Their acquisition is probably restricted by the specialized feeding habits of blue whales. However, the occurrence of *D. balaenopterae* in blue whales suggests that they ingest more than the occasional accidental fish (second intermediate host?). Blue whales may ingest up to 4 tons of krill per day during the feeding season (Lockyer, 1981). Because fish such as capelin and herring also feed on swarms of krill, it is not surprising that blue whales may ingest some of these fish during feeding. This may also explain reports of *Anisakis* sp. and *Pseudoterranova* sp. if fish are obligate hosts.

Quantitative data on helminths of blue whales are not available in the literature, which is not surprising given the dimensions of the gastrointestinal tract; the intestine may be up to 150 m long! However, future studies should be directed to determinations of intensities, particularly with a view to understanding the population dynamics of zoonotic parasites such as species of *Anisakis* and *Diplogonoporus.*

Acknowledgment

I am grateful to Richard Arthur who helped in the literature search and reviewed the manuscript.

Literature Cited

Arvy, L. 1977. La peau, les phanères et leurs parasites chez les cétacés. Vie et Milieu 27(série A):137–190.

———. 1982. Phoresies and parasitism in cetaceans: a review. Investigations on Cetacea 14:233–335.

Barnard, K. H. 1931. Diagnoses of new genera and species of amphipod Crustacea collected during the 'Discovery' investigations, 1925–1927. Annals and Magazine of Natural History, Series 10, 7:425–430.

———. 1932. Amphipoda. Discovery Reports 5:1–326.

Baylis, H. A. 1920. Observations on the genus *Crassicauda.* The Annals and Magazine of Natural History 5:410–419.

———. 1929. Parasitic Nematoda and Acanthocephala collected in 1925–1927. Discovery Reports 1:541–559.

———. 1932. A list of worms parasitic in Cetacea. Discovery Reports 6:393–418.

Beaver, P. C., T. Otsuji, A. Otsuji, H. Yoshimura, R. Uchikawa, and A. Sato. 1983. Acanthocephalan, probably *Bolbosoma,* from the peritoneal cavity of man in Japan. American Journal of Tropical Medicine and Hygiene 32:1016–1018.

Berzin, A. A., and L. P. Vlasova. 1982. Fauna of the Cetacea Cyamidae (Amphipoda) of the world ocean. Investigations on Cetacea 13:149–164.

Carl, G. C., and G. V. Wilby. 1945. Some marine fish records for British Columbia. Canadian Field-Naturalist 59:28–30.

Clarke, R. 1966. The stalked barnacle *Conchoderma,* ectoparasitic on whales. Norsk Hvalfangst-Tidende 8:153–168.

Cockrill, W. R. 1960. Pathology of the Cetacea. A veterinary study on whales. Part 1. The British Veterinary Journal 116:133–144.

Dailey, M. D., and R. L. Brownell, Jr. 1972. A check-

Copyright © 2011, The Helminthological Society of Washington

list of marine mammal parasites. Pages 528–589 *in* S. H. Ridgway, ed. Mammals of the Sea. Charles C Thomas, Springfield, Illinois. 812 pp.

Delyamure, S. L. 1955. Helminthofauna of marine mammals. *In* K. I. Skrjabin, ed. Izdatelstvo Akademii Nauk SSSR, Moscow. Translated from Russian by Israel Program for Scientific Translations, Jerusalem, 1968. 522 pp.

Follett, V. I., and L. J. Dempster. 1960. First records of the echeneidid fish *Remilegia australis* (Bennett) from California, with meristic data. Proceedings of the California Academy of Science 31: 169–184.

Gibson, D. I. 1973. Some blue whale nematodes. Parasitology 67:viii–ix.

———**, and E. A. Harris.** 1979. The helminth-parasites of cetaceans in the collection of the British Museum (Natural History). Investigations on Cetacea 10:309–324.

Hoberg, E. P. 1987. Recognition of larvae of the Tetrabothriidae (Eucestoda): implications for the origin of tapeworms in marine homeotherms. Canadian Journal of Zoology 65:997–1000.

Jackson, G. J. 1975. The "new disease" status of human anisakiasis and North American cases: a review. Journal of Milk and Food Technology 38: 769–773.

Jagerskiold, L. A. 1891. Einiges uber die Schmarotzer der nordatlantischen Balaenopteriden. Biologiska Foreningens Forhandlingar, Stockholm 3:127–134. (In German.)

Kakuwa, Z., T. Kawakami, and K. Iguchi. 1953. Biological investigation on the whales caught by the Japanese Antarctic whaling fleets in the 1951–52 season. Scientific Reports of Whale Research Institute, Tokyo 8:147–213.

Kamo, H., S. Iwata, R. Hatsushika, and J. Maejima. 1973. Experimental studies on the life-cycle of *Diplogonoporus grandis*. II. Experimental infection of marine copepods with coracidia. Japanese Journal of Parasitology 22:79–89.

Klumov, S. K. 1963. Food and helminth fauna of whalebone whales (Mystacoceti) in the main whaling regions of the world ocean. Trudy Instituta Okeanologii 71:94–194. (In Russian.) Fisheries Research Board of Canada Translation Series No. 589, 1965.

Lambertsen, R. H. 1985. Taxonomy and distribution of a *Crassicauda* species (Nematoda: Spirurida) infecting the kidney of the common fin whale (*Balaenoptera physalus* Linné, 1758). Journal of Parasitology 71:485–488.

———. 1986. Disease of the common fin whale (*Balaenoptera physalus*): crassicaudiosis of the urinary system. Journal of Mammalogy 67:353–366.

Leatherwood, S., C. B. Peters, R. Santerre, and J. T. Clarke. 1984. Observations of cetaceans in the Northern Indian Ocean Sanctuary November 1980 through May 1983. Report of the International Whaling Commission 34:509–520.

Lockyer, C. 1981. Growth and energy budgets of large baleen whales from the southern hemisphere. Mammals in the Seas. Vol. 3. FAO Fisheries Series 5:379–484.

Mackintosh, N. A., and J. F. G. Wheeler. 1929. Southern blue and fin whales. Discovery Reports 1:257–540.

Margolis, L. 1954. List of the parasites recorded from sea mammals caught off the west coast of North America. Journal of the Fisheries Research Board of Canada 11:267–283.

———. 1977. Public health aspects of "codworm" infection: a review. Journal of the Fisheries Research Board of Canada 34:887–898.

———**, and M. D. Dailey.** 1972. Revised annotated list of parasites from sea mammals caught off the west coast of North America. U.S. Department of Commerce, National Oceanic and Atmospheric Administration Technical Report NMFS SSRF-647. 23 pp.

Markowski, S. 1955. Cestodes of whales and dolphins from the Discovery collections. Discovery Reports 27:377–395.

McClelland, G. 1990. Larval sealworm (*Pseudoterranova decipiens*) infections in benthic macrofauna. Pages 47–65 *in* W. D. Bowen, ed. Population Biology of Sealworm (*Pseudoterranova decipiens*) in Relation to Its Intermediate and Seal Hosts. Canadian Bulletin of Fisheries and Aquatic Sciences 222. 306 pp.

Measures, L. N. 1992. *Bolbosoma turbinella* (Acanthocephala) in a blue whale, *Balaenoptera musculus*, stranded in the St. Lawrence Estuary, Quebec. Journal of the Helminthological Society of Washington 59:206–211.

Nemoto, T. 1959. Food of baleen whales with reference to whale movements. Scientific Reports of Whale Research Institute, Tokyo 14:149–290.

Nilsson-Cantell, C. A. 1930. Thoracic cirripedes collected in 1925–1927. Discovery Reports 2:223–260.

———. 1939. Thoracic cirripedes collected in 1925–1936. Discovery Reports 18:223–238.

Nishiwaki, M., and K. Hayashi. 1950. Biological survey on fin and blue whales taken in the Antarctic season 1947–48 by the Japanese fleet. Scientific Reports of Whale Research Institute, Tokyo 3:132–190.

———**, and T. Oye.** 1951. Biological investigation on blue whales (*Balaenoptera musculus*) and fin whales (*Balaenoptera physalus*) caught by the Japanese Antarctic whaling fleets. Scientific Reports of Whale Research Institute, Tokyo 5:91–167.

Ohno, M., and R. Fujino. 1952. Biological investigation of the whales caught by the Japanese Antarctic whaling fleets, season 1950–51. Scientific Reports of Whale Research Institute, Tokyo 7:125–188.

Oshima, T., and M. Kliks. 1986. Effects of marine mammal parasites on human health. Pages 415–421 *in* M. J. Howell, ed. Parasitology Quo Vadit? Proceedings of the Sixth International Congress of Parasitology, Canberra.

Petrochenko, V. I. 1956. Acanthocephala of domestic and wild animals. Vol. I. *In* K. I. Skrjabin, ed. Izdatelstvo Akademii Nauk SSSR, Moscow. Translated from Russian by Israel Program for Scientific Translations, Jerusalem, 1971. 464 pp.

———. 1958. Acanthocephala of domestic and wild animals. Vol. II. *In* K. I. Skrjabin, ed. Izdatelstvo Akademii Nauk SSSR, Moscow. Translated from Russian by Israel Program for Scientific Translations, Jerusalem, 1971. 478 pp.

Copyright © 2011, The Helminthological Society of Washington

Porta, A. 1908. Gli acantocefali dei mammiferi. Archives de Parasitologie 12:268–282.

Quidor, A. 1910. Note préliminaire sur *Penella balaenopterae* (Koren et Danielssen). Bulletin Musée Histoire Naturelle 16:97–98.

Raga, J. A., and J. A. Balbuena. 1990. A new species of the genus *Crassicauda* Leiper et Atkinson, 1914 (Nematoda: Spiruroidea) from the penis of *Globicephala melas* (Traill, 1809) (Cetacea: Globicephalidae) in the western Mediterranean Sea. Annales de Parasitologie Humaine et Comparée 65:255–261.

Rees, G. 1953. A record of some parasitic worms from whales in the Ross Sea area. Parasitology 43: 27–34.

Rice, D. W. 1963. Progress report on biological studies of the larger Cetacea in the waters off California. Norsk Hvalfangst-Tidende 7:181–187.

———. 1978. Blue whale. Pages 31–35 *in* D. Haley, ed. Marine Mammals of Eastern North Pacific and Arctic Waters. Pacific Seattle Press, Seattle. 256 pp.

———**, and D. K. Caldwell.** 1961. Observations on the habits of the whalesucker (*Remilegia australis*). Norsk Hvalfangst-Tidende 5:189–193.

Shimazu, T. 1975. Some cestode and acanthocephalan larvae from euphausiid crustaceans collected in the northern Pacific Ocean. Bulletin of the Japanese Society of Scientific Fisheries 41:813–821. (In Japanese.)

Skrjabin, A. S. 1959. New helminth species from marine mammals in the Pacific Ocean and far-eastern seas. Izvestiya Krimskovo Pedagogicheskogo Instituta M.V. Frunze 34:99–118. (In Russian.)

———. 1969. A new species of trematode of the genus *Ogmogaster* (Notocotylidae) parasite of whalebone whales. Zoologicheskii Zhurnal 48: 1882–1885. (In Russian.)

Small, G. L. 1971. The Blue Whale. Columbia University Press, New York. 248 pp.

Smith, J. W. 1983. *Anisakis simplex* (Rudolphi, 1809, det. Krabbe, 1878) (Nematoda: Ascaridoidea): morphology and morphometry of larvae from euphausiids and fish, and a review of the life-history and ecology. Journal of Helminthology 57:205–224.

Tada, I., Y. Otsuji, H. Kamiya, T. Mimori, Y. Sakaguchi, and S. Makizumi. 1983. The first case of a human infected with an acanthocephalan parasite, *Bolbosoma* sp. Journal of Parasitology 69: 205–208.

Turner, W. 1905. On *Pennella balaenopterae*: a crustacean, parasitic on a finner whale, *Balaenoptera musculus.* Transactions of the Royal Society, Edinburgh 41:409–434.

Yochem, P. K., and S. Leatherwood. 1985. Blue whale, *Balaenoptera musculus* (Linnaeus, 1758). Pages 193–240 *in* S. H. Ridgway and R. Harrison, eds. Handbook of Marine Mammals. Vol. 3. Academic Press Inc., London. 362 pp.

The Coccidia of the World: a Central Clearing House

We are attempting to assemble a complete collection of the World's literature on the coccidia (Family Eimeriidae) of both invertebrate and vertebrate animals on a computer data base. Descriptive data on all oocyst and life cycle stages will be entered and cross-referenced by species, host(s), locality, author, and perhaps other parameters. The data will then be compiled by host group in whatever way seems most useful (e.g., invertebrate hosts by Phylum; vertebrate hosts by Family). Once established, the data base can be added to and archived in appropriate places (e.g., the U.S. National Parasite Collection, Beltsville, MD) on a regular basis (e.g., each decade), and it can be made available to workers in the field for the cost of reproducing and mailing computer disks or hard copy. We would appreciate receiving a copy of any and all published papers in your reprint collection in which new species of coccidia are described or redescribed. Of most value are copies of old papers that have appeared in specialty journals or in non-English journals with limited circulations. Please mail reprints to: Dr. Donald W. Duszynski, at the address below. Also, please continue to send copies of new papers as they are forthcoming. Any constructive suggestions you may have in this regard are welcomed. We thank you in advance for your cooperation.

Dr. Donald W. Duszynski
Department of Biology
The University of New Mexico
Albuquerque, New Mexico 87131
U.S.A.

Dr. Steve J. Upton
Division of Biological Sciences
Ackert Hall
Kansas State University
Manhattan, Kansas 66506
U.S.A.

Copyright © 2011, The Helminthological Society of Washington